

White Paper Report

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1. Cover Page

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2. Narrative Description

a. Project Activities

Digital Epigraphy Toolbox is a novel open-source and technologically advanced scientific tool for the effective study and comparative analysis of Greek and Latin inscriptions. It provides archaeologists and epigraphists with a cost-effective and efficient method for 3D digitization of inscriptions based on squeezes, comparative analysis, as well as access to an online dynamic library of 3D inscriptions. For the development of this software application several programming languages and tools were employed such as Java, PHP, OpenGL, MySQL, and XML.

The main program (client) was developed in Java (<http://www.java.com>) using the software developing program Eclipse (<http://www.eclipse.org>). The program renders 3D models of inscriptions using the graphics processor unit (GPU) of the user's computer, when available. The graphics are displayed using the OpenGL (<http://www.opengl.org>) library that communicates directly with the graphics processor and produces efficient 3D rendering. The OpenGL library is connected with Java using a popular library called JOGL (<http://www.jogamp.org/>) that has been used in many projects from NASA and other institutes. This library has been tested in many popular operating systems such as Windows, Mac, Linux, Solaris, and Android.

The program communicates with a server application that is installed at the University of Florida and runs in the following public IP address: 128.227.74.140. The server was programmed using the server-side scripting language php (<http://www.php.net/>). The main program communicates with the server using HTTP requests that can also be sent manually by any web-browser, which allows other researchers to develop their own applications that can communicate with our server. The server has a database of epigraphic entries that contains images in PNG format, height-maps in PNG format, and several fields of text-based information stored in a MySQL database (<http://www.mysql.com/>) as well as in XML files.

There are a few differences in the structure of our database from our initial proposed design. In our original proposal the server would respond to a search query sent by the client application in the form of an php-generated XML response that will contain the full epigraphic entries that contain the search keywords. However, after user testing it was found that this solution produces significant computational overhead in the server, which may have as a result slower response cycles. To overcome this problem the design of the database was restructured so that the full contents of each epigraphic entry is saved in a separate XML file, which can be downloaded by the client per demand using a simple HTTP request without producing additional computational overhead. In this design the responses received by the server contain only a list of the ID numbers of the epigraphic records that satisfy the search query. The client receives the list of ID numbers and then it gradually downloads the full epigraphic records per user's demand.

Furthermore, the number of available fields in the database was increased (compared to those initially listed in our proposal). After discussion with users several new fields were added to the database and they were also categorized thematically. The overall design of the database was changed so that in the future new fields may be introduced by the users without significant changes in the database. To be more precise, the structure of the database, including the number and type of fields, is stored in a separate database table, which can be easily reconfigured. The software reads first this database configuration file and understands how the database is structured, producing the appropriate database forms that can be used by the users. Another reason for using this generic database structure is to expand it easily so that in

the near future it can accommodate other archaeological records, such as coins, medals, seals, and others archaeological artifacts with 3D structure.



Digital Epigraphy Toolbox was accepted for presentation in the 14th Congress of Greek and Latin Epigraphy hosted by Humboldt University, August 27-31, 2012. During our presentation the developed system was officially released to the public, followed by a live demo of the 3D on-line epigraphic toolbox that was attended by more than a hundred conference attendees, right after the grand opening of the www.digitalepigraphy.org web-site that hosts our system. The picture on the left shows Dr. Eleni Bozia demonstrating the Digital Epigraphy Toolbox in the Senate Hall at the Humboldt University on August 28, 2012.

The software was also demonstrated at the Berlin-Brandenburg Academy of Sciences and Humanities that carries various epigraphic collections such as the Corpus Inscriptionum Latinarum, the Inscriptiones Graecae, and the Altägyptisches inscriptions. During our presentation the audience had the chance to interact with 3D digital inscriptions and learn

more about our novel cost-effective 3D digitization technique.

Furthermore our team was invited to give a lecture in the e-humanities lecture series organized by the University of Leipzig in December 19, 2012. The title of our presentation was 'The First Online 3D Epigraphic Library'. The slides of our presentation are available here: <http://www.e-humanities.net/events/2012-ehum-seminar-call.html>

Finally, we are in the process of writing a paper describing the Digital Epigraphy Toolbox and the new research capabilities that provides to scholars. The article is expected to be published in an edited volume on Digital Humanities. The volume is organized and edited by Marco Büchler.

b. Accomplishments

The proposed goals of this project were achieved, including the development of the main software (client), the development of the server software (which includes the database structure), the release of the system to the public, and the presentation of the software in several epigraphic or digital humanities conferences/seminars. In addition we have started digitizing squeezes from various collections and entering them into the on-line 3D epigraphic database, although the proposed project was not a digital collection project. We are currently in the process of seeking funding to support the digitization of collections in order to populate the 3D database.

c. Audiences

Within the first 18 months of the start-up phase of the Digital Epigraphy Toolbox project, our group has developed an international network of digital humanists, archaeologists, classicists, historians, epigraphists, anthropologists, and computer scientists who participated in our project or used its products. A few examples of our active collaborations are listed below:

Tampa Museum of Art: Dr. Seth Pevnick, Chief curator of Greek and Roman Art, supervises the 3D scanning of Greco-Roman artifacts that will be included in the next version of our extended database and provides scientific interpretation of their 3D analysis.

University of California Berkeley: Prof. Kim Shelton, Director of the Nemea Center for Classical Archaeology, provides squeezes of inscriptions from the Nemea project for 3D digitization using the Digital Epigraphy Toolbox.

Marquette University: Prof. Sarah Bond, department of History, uses 3D prints of inscriptions from the Digital Epigraphy Toolbox in classroom as an education tool, instead of plaster casts. After interaction with her we added a few more features to our software application including the option to download a 3D model in a format that can be opened by 3D printers.

Ohio State University: Prof. Stephen V. Tracy, Professor Emeritus, after communication with our team members he will include a brief description of our tool and its main capabilities in his forthcoming book “Handbook of Greek Epigraphy”, *Oxford University press*.

University of Lyon: Prof. Michèle Brunet, Director of HISOMA (History and Sources of World Antiquities), started joint student supervision with members of our group (Dr. Bozia) on 3D Epigraphic Techniques.

d. Evaluation

An objective form of evaluation of the overall quality of the project and its accomplished goals is the “eHumanities Innovation” competition organized by the University of Leipzig, which awarded the 2nd place to the Digital Epigraphy Toolbox. Our team received the award in a ceremony organized by the University of Leipzig in December 2012. Several projects from different universities and institutes from various countries participated in this competition. The USA were represented by many projects two of which won an award, the University of Florida (2nd place) and the University of California Berkeley (3rd place).

The Digital Epigraphy Toolbox was reviewed by Marco Büchler, Technical Project Manager at the University of Leipzig, who stated the following in his recommendation: “The team applied for the *eHumanities Innovation Award* that was highly competitive. As co-organizer and initiator of this award, it is my pleasure to inform you that the team was awarded with the 2nd place. During the entire process, this contribution was one of the strongest candidates for this award. Both by the excellent presentation in the seminar and by the very competitive contribution for our award, I can say that the team is highly innovative, smart, and highly motivated.... It is my strong belief that the Digital Epigraphy and Archaeology group have great potential and that their proposed project will be a valuable contribution to the field of Digital Humanities.”

e. Continuation of the Project

Expansion of the Digital Epigraphy Toolbox

We have already started working towards the extension of the *Digital Epigraphy Toolbox*, in order to offer several new options for automatic statistical analysis of other 3D digitized archaeological artifacts, such as coins and sculptures. We have applied for an Implementation Grant that will give us the opportunity to build on our existing algorithms. The extended version of the *Digital Epigraphy Toolbox* will assist individual archaeologists, institutions, and museums in studying the structure of artifacts, such as coins, statues, busts, lamps, and vases, their construction techniques and patterns that appear on their surfaces and also in performing comparison between similar artifacts.

Also, we plan to apply for Collections and Preservation Grants through which we will create online dynamic libraries of both 3D digitized squeezes and artifacts. Therefore, museums, institutions, and individual collectors will have a tool by means of which they will digitize in 3D their collections, preserve them electronically, and make them accessible to others.

Academic Promotion

We intend to organize discussion panels in national and international epigraphic and archaeological meetings (specifically in the annual meeting of the Archaeological Institute of America) in order to demonstrate our system. This way we will promote the dissemination of our product, while significantly increasing the number of active users and the number of institutes that will contribute to the digital 3D database.

We are already working towards the publication of our results from the statistical analysis of archaeological artifacts in major journals in the areas of computer science, archaeology, and digital humanities. We are also invited by the University of Leipzig to contribute a paper to their edited volume on Digital Humanities.

f. Long Term Impact

Impact on the Humanities

The *Digital Epigraphy Toolbox* significantly contributes and promotes epigraphic and archaeological studies. It is also a significant presence in the area of Digital Humanities as it successfully advances the Humanities through state-of-the-art technologies.

Impact on the University of Florida

The *Digital Epigraphy Toolbox* is the first Digital Humanities project developed at the University of Florida that was funded by the NEH Office of Digital Humanities start-up grant. Soon after the *Digital Epigraphy Toolbox* became an NEH funded project, the *Digital Humanities Working Group* was established at the University of Florida. Dr. Barmpoutis, Dr. Bozia, and Dr. Wagman are among its members. The *Digital Humanities Working Group* meets once a month and its goal is to discuss issues that concern this new field of research and also attract more students and faculty.

Colleagues from other areas of research have expressed interest in the Digital Humanities and our group. Dr. Barmpoutis, Dr. Bozia, and Dr. van Steen, Professor at the Department of Classics at the University of Florida, who works on Greek Theater, have started collaborating in another innovative project on Digital Humanities. In September 2012 we applied for a start-up grant which will allow us to create a novel system that will help students and researchers understand the circumstances of performance in classical drama and ultimately interpret more accurately the original text, especially when the spatiotemporal interactions of the portrayed characters play significant role in the study of the text.

Impact on the Academic Community

Dr. Barmpoutis, Dr. Bozia, and Dr. Wagman are also founding members of the *Digital Classics Association* that was founded in the Spring of 2012. The first meeting will be held in April 2013 in New York. The *Digital Classics Association* has also managed to establish a panel at the annual joint meeting of the America Philological Association and the American Institute of Archaeology, which will be first organized in January 2014 in Chicago, IL.

g. Grant Products

The main goal of this project was to develop a computer program for the effective study and analysis of Greek and Latin inscriptions. The program that was created is the *Digital Epigraphy Toolbox*, which provides archaeologists and epigraphists with a cost-effective and efficient method for 3D digitization of inscriptions based on squeezes, as well as access to an online dynamic library of 3D inscriptions.

Digital Epigraphy Toolbox offers many options and features such as: on-line database of 3D inscriptions, 3D rotation, change lighting orientation, zoom in/out, thematic browsing, keyword searching, downloading of epigraphic database entries, connecting with other existing on-line libraries, dynamic and open editing of the epigraphic records by the research community, statistical comparative analysis of inscriptions, and many other features.

One of our major goals in this project was to develop a cross-platform system in order to increase as much as possible the audience (users) of our software. The developed software runs on most major operating systems: Windows, Mac, Linux, and Solaris. Java must be installed, a cross-platform software that can be downloaded for free from (<http://www.java.com>). Internet is required in order to connect to our on-line epigraphic database. Digital Epigraphy Toolbox can be accessed at the following URL address: <http://www.digitalepigraphy.org/toolbox> using a web-browser. Depending on the configuration of your browser the software may run as an application embedded on a web-page or as a stand-alone application.

In order to support the development of other software applications in other similar areas in the Humanities we provide the source code of this project. The source code is written in Java and can be downloaded from the following URL address: <http://www.digitalepigraphy.org/DEA.jar>. The downloaded file is a compressed folder (Java Archive / JAR) and can be uncompressed using any standard software for browsing compressed files. Once the file is uncompressed its contents will be extracted to your local hard disk including several java source code files organized properly in sub-folders. Some parts of the source code contain links to external java libraries such

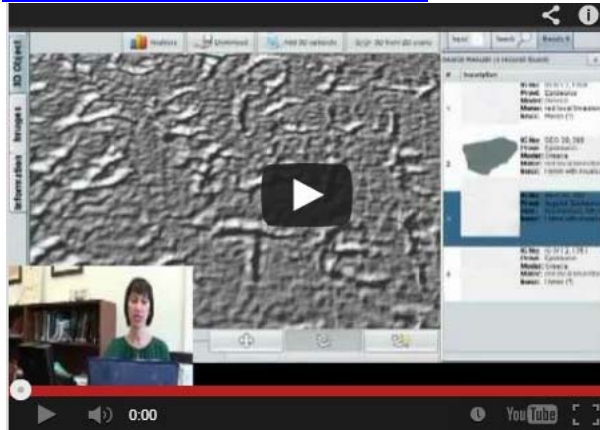
as the JavaFX library developed by Oracle Corporation and the JOGL library for fast rendering of 3D graphics using OpenGL.

Furthermore, a web-site was created as part of this project in order to disseminate the Digital Epigraphy Software and provide information to the community about the current features of this project, updates, and future goals and directions. The web-site can be found at the following URL: <http://www.digitalepigraphy.org>. The web-site also contains a quick user guide, contact details, information about the funding agencies and grants that support the development of this project, and useful links to external web-sites.

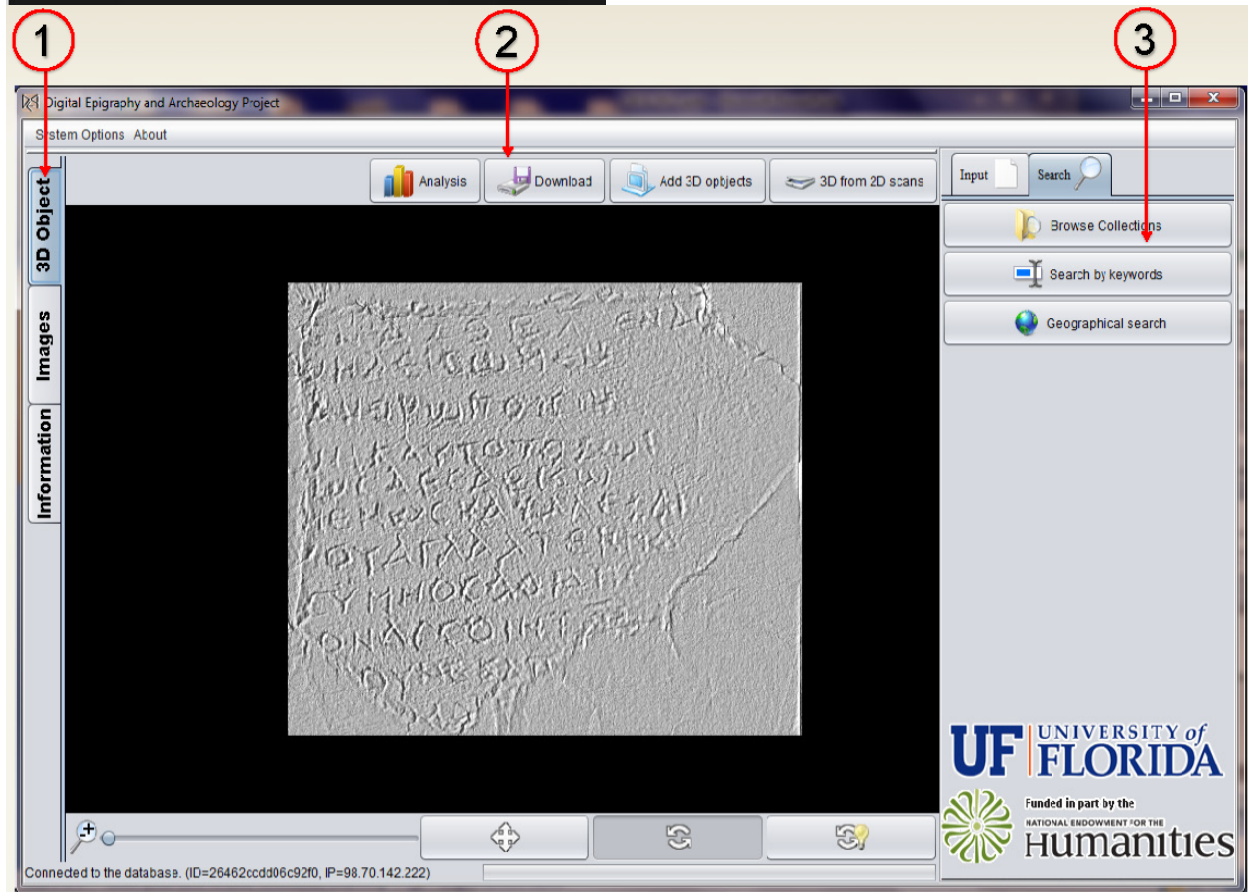
Finally, short video presentations were created and are currently available through the <http://www.digitalepigraphy.org> web-site. All of the videos are hosted by the www.youtube.com service and are also accessible by google search. One of the produced videos presents the main idea behind the digital epigraphy toolbox and was filmed during our presentation at the 2012 Interface seminar. The video presentation can be accessed by following the following URL: <http://www.youtube.com/watch?v=Ef433X5rvaE>. A second video was also produced that presents the graphical user interface of the Digital Epigraphy Toolbox and its key features. The video shows screen captures of our software and can be viewed by the following URL address: <http://www.youtube.com/watch?v=WUd333VdgCk>.

3. Appendix - Screenshots from the Digital Epigraphy Toolbox (www.digitalepigraphy.org)

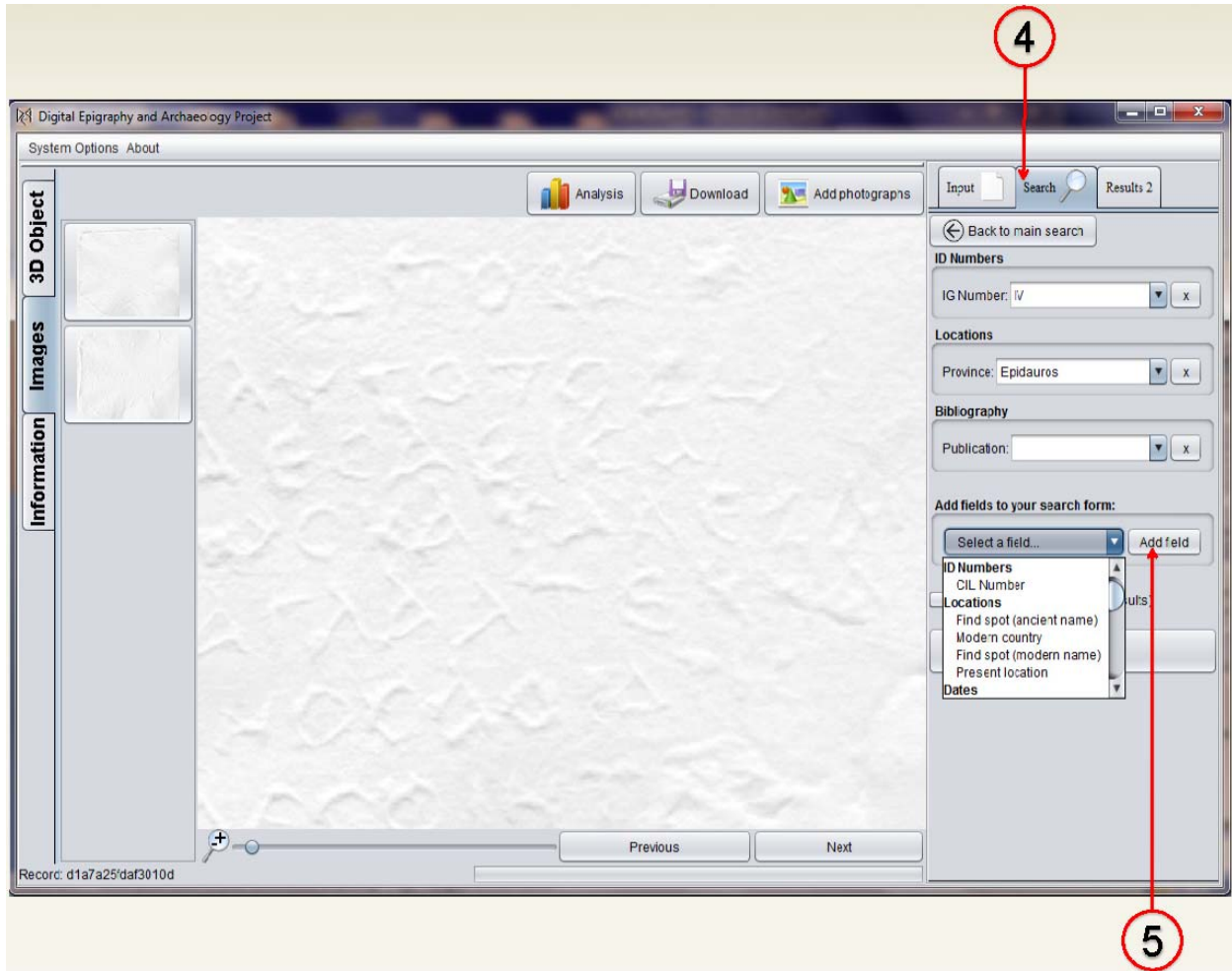
Below we have included screenshots from the Digital Epigraphy Toolbox. The toolbox is available online at <http://www.digitalepigraphy.org>.



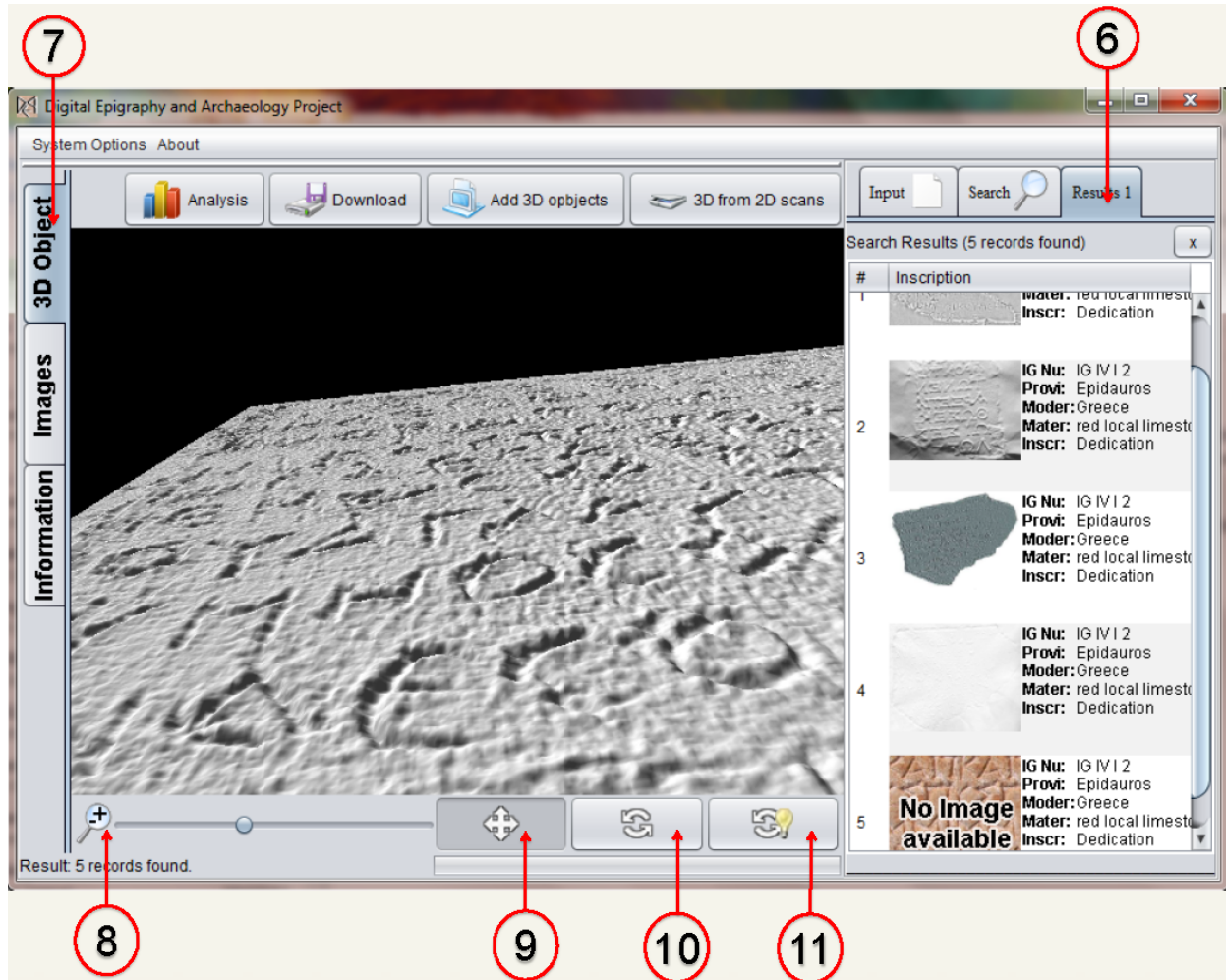
We have also created a short (4 min) video that demonstrates the Digital Epigraphy Toolbox and some of its key functionalities. The video is available at: <http://www.youtube.com/watch?v=WUd333VdgCk>



1. There are 3 modes of inscription viewing: 3D model, 2D images, and textual information.
2. The user interface offers many options, such as downloading existing epigraphic records and adding new data.
3. The user can browse through our collection, search for an inscription by keywords, or perform geographical search.



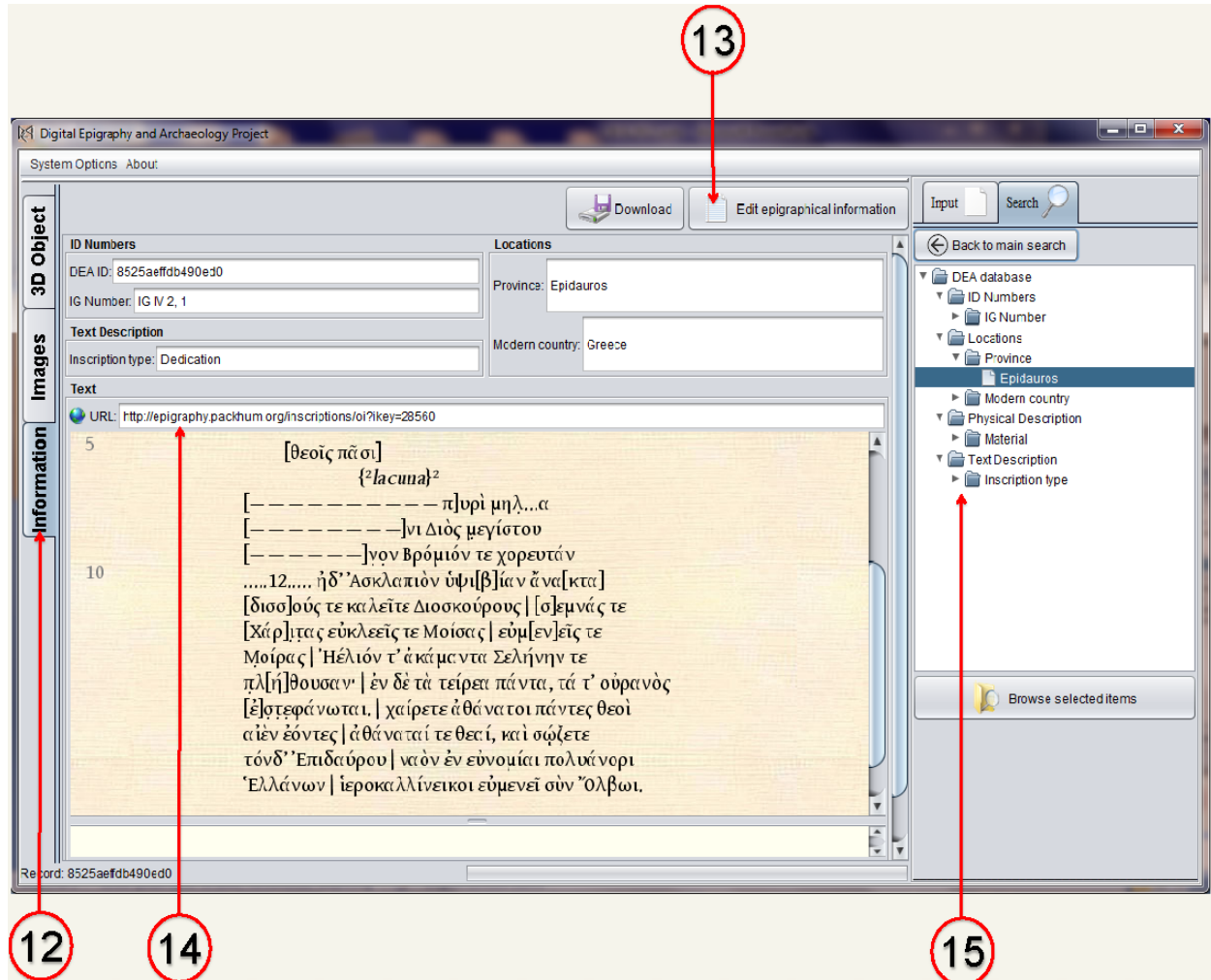
4. The user can search by typing full or partial keywords.
5. The search form can be customized by adding fields, such as IG/CIL number, location, dates, bibliographical information about an inscription.



6. A comprehensive list of results is generated after each search query.

7. Example of a 3D object view.

8,9,10,11. The user can zoom, move, rotate, and manipulate the lighting to achieve better viewing of the 3D model.



12. This is an example of the epigraphic record view.
13. Authorized users may edit the epigraphic information of an existing record.
14. The epigraphic record may include links to other existing epigraphic databases.
15. Additionally, the user may navigate our database via thematic browsing.